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Stefan Gerlach and *Matthew S. Yiu*

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Unobservable-Component Estimates of Output Gaps in Five Asian Economies

Stefan Gerlach
Hong Kong Monetary Authority
Hong Kong Institute for Monetary Research
University of Basel and CEPR

and

Matthew S. Yiu
Hong Kong Institute for Monetary Research

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Abstract

This paper estimates output gaps for Hong Kong, Korea, the Philippines, Singapore and Taiwan, employing the HP filter and unobservable-components (UC) techniques. The latter approach assumes that actual output is the sum of potential output, which follows a random walk with a time-varying drift, and a stationary output gap. While the results imply that UC methods are useful in estimating output gaps in Asia, simple Phillips curves suggest that the information contents of the two measures of the gap are essentially identical. The main advantage of the UC technique is that it allows the construction of confidence bands for the gap.

JEL: C5, E3
Key words: Output gaps, unobservable components, Kalman filtering

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1. Introduction

The output gap — the difference between actual and potential output — plays a central role in macroeconomic theory and, in many economies, in the practical conduct of monetary policy. There is a large body of evidence indicating that inflationary pressures tend to increase as output rises, and decline when output falls, relative to potential.[1] Reflecting its importance as a determinant of inflation, the output gap naturally plays an important role also in the conduct of monetary policy, particularly for those central banks that gear policy to achieving and maintaining low inflation. Following the seminal contribution of Taylor (1993), a number of studies have demonstrated that the output gap is significant in estimated reaction functions for central banks.

One problem concerning the output gap is that it is an unobserved variable. Any analysis of its importance in the inflation process and for the setting of monetary policy thus requires it to be estimated. For this reason, a large empirical body of work on the empirical modelling of potential output has developed. Several different research strategies have been applied in the literature. These may be usefully thought of as either following an atheoretical approach, a structural approach or a mixed approach.

The first of these strategies sees the problem of estimating potential output as a statistical exercise in which actual data on output are used to construct an estimate of potential output. The simplest example of this approach is to regress the logarithm of actual output on a time trend and, perhaps, a squared time trend and use the residuals as a measure of the output gap. Alternative approaches are to use the popular Hodrick-Prescott (HP) filter (1997), or the more refined unobservable-components (UC) time-series methods proposed by Beveridge and Nelson (1981), Watson (1986) and Clark (1989). Despite its popularity, the atheoretical modelling strategy suffers from the drawback that it relies solely on data on actual output when constructing estimates of the gap. The fact that many other macroeconomic variables are likely to contain information about where actual output is relative to potential is thus disregarded, implying that this approach uses a perhaps too narrow information set. For instance, the permanent income hypothesis of consumption suggests that private saving is correlated with the difference between current and permanent income and thus the output gap. Moreover, the literature on the Phillips curve implies that the difference between actual and expected inflation, or the change in inflation, contains information about the output gap. Such information could in principle be usefully incorporated in the estimation of the gap.

Structural approaches to the estimation of the output gap exploit economic theory to estimate potential output. A common strategy is to use data on employment and estimates of the capital stock to fit a production function, and to make assumptions about "normal" levels of employment, productivity and the use of the capital stock to construct potential output. While the guidance of economic theory is attractive, this approach is subject to several problems. In particular, the data requirements may be burdensome, particularly for emerging market or newly industrialized economies for which information, or long time series, on key variables may be missing. Moreover, the use of structural information is a potential source of specification error. For instance, unless the aggregate production function is correctly specified, the resulting output gap estimates may be poor. Finally, the calculation of the "normal" level

[1] See for instance the October 1999 special issue of the Journal of Monetary Economics, entitled "The Return of the Phillips Curve". BIS (1997, 2001a, 2001b) contains a number of references to central bank research on the inflation process, including the role of the output gap.

of employment etc. is not trival. Moreover, it essentially shifts the problem of removing cyclical fluctuations from output to the input variables.

A third strategy, the mixed approach, is to combine the time series strategy with structural economic information. Kuttner (1994) combines a Phillips curve and an UC model, and uses data on actual output and inflation to estimate the output gap in the US. Gerlach and Smets (1997, 1999) use this strategy to estimate output gaps in the G-7 countries and in the Euro Zone. While this approach is attractive, a critical maintained assumption is that the relationship between the output gap and inflation is stable during the sample period. Needless to say, many researchers may find this assumption unattractive.

In this paper we follow the atheoretical time series approach proposed by Watson (1986) and Clark (1989) and estimate the output gap in five Asian economics — Hong Kong, Korea, Thailand, the Philippines and Singapore — using quarterly data starting in the early 1970s. The reasons for this choice are three-fold. First and most importantly, estimating the output gap using the structural approach requires economic relationships to have remained stable during the sample period. While this assumption may be reasonable for more advanced economies, the emerging market economies we are studying here have undergone a deep and far-reaching economic transformation in the data period. We are therefore hesitant to assume that the economic structure is fixed in the sample.

Second, the time-series approach has the advantage that it is possible to construct a confidence band for the output gap and for the growth rate of potential output. It is well known that it is difficult to estimate the output gap with a high degree of precision. For this reason it is desirable to have a measure of just how uncertain our estimates are.

Third, there are, as far as we know, no published studies that use the UC time-series technique to model output gaps in Asian economies. The results below may thus be of some methodological interest.

The rest of the paper is organized as follows. In Section 2 we review the specification of the Clark-Watson (CW) model of the output gap. This model views actual output as the sum of two unobserved variables, potential output and the output gap. The key assumption, which allows the two unobserved components to be estimated, is that the output gap evolves over time as a second-order autoregressive process. In Section 3 we turn to the estimates of the model. We find that, overall, the estimated output gaps are broadly similar to those resulting from use of the HP filter. We also fit standard backward-looking Phillips curves to explore the relationship between the two measures of the output gap and inflation. Overall, these appear to be equally important in accounting for movements in inflation. This finding suggests that it may be appropriate to use output gaps constructed using the HP filter, which are easier to calculate, for applied work. The main attraction of using the UC model is that it allows us to estimate confidence bands for the output gap. Section 4 concludes.

2. The Clark-Watson Model

In this section we present the time series model we use to estimate the output gap. We first outline the model, show how it can be written in state-space form and discuss how to fit it using Kalman filtering.

2.1 Specification

The specification for output follows Watson (1986). Let y_t, y_t^p and z_t denote the logarithms of actual and potential output and the output gap. Of course, we only have data on actual output and the purpose of the exercise is to estimate the latter two variables. To do so, we start from the identity:

$$y_t \equiv y_t^p + z_t \ , \tag{1}$$

that is, actual output is defined as the sum of potential output and the output gap. Next we assume that potential output follows a random walk with drift, that is,

$$y_t^p = \mu_t + y_{t-1}^p + \varepsilon_t^y \ , \tag{2}$$

where μ_t denotes the rate of drift and where $\varepsilon_t^y \sim N(0, \sigma_y^2)$. Notice that μ_t may be thought of as the rate of growth of potential output. While the emphasis of the analysis below is on the output gap, we will also discuss the estimated growth rates of potential.

As evidenced by the time subscript, we allow the rate of drift to vary over the sample period as suggested by Clark (1989). Formally we let the drift parameter follow a random walk:

$$\mu_t = \mu_{t-1} + \varepsilon_t^\mu \tag{3}$$

where $\varepsilon_t^\mu \sim N(0, \sigma_\mu^2)$. Note that if $\varepsilon_t^\mu = 0$, the rate of growth is constant over the sample. This is the assumption made by Watson (1986). While it seems to fit the US data quite well, the results in Gerlach and Smets (1997) indicate that this assumption is restrictive in the case of other economies. We therefore let the rate of growth vary over time.

We close the model by assuming a time series process for the output gap, z_t. As mentioned above, the CW-model assumes that the gap evolves over time according to a second-order auto-regressive process

$$z_t = \phi_1 z_{t-1} + \phi_2 z_{t-2} + \varepsilon_t^z \tag{4}$$

where $\varepsilon_t^z \sim N(0, \sigma_z^2)$. One implication of the choice of an AR(2) process is that, depending on the estimates of the AR-parameters, z_t may have complex roots and, if so, obey a cyclical process.[2]

2 Yin-Wong Cheung has pointed out that since potential output is assumed to follow a random walk, the growth rate of real output is non-stationary. This hypothesis is easily rejected by the data. To understand why, note that the variance of the shocks to potential output is much smaller than the variance of the shocks to the output gap. Thus, the time series behaviour of output growth is dominated by changes in the output gap, leading the Augmented Dickey Fuller test falsely reject the hypothesis of non-stationarity. To explore this, we conducted a Monte Carlo study in which we used the parameter estimates from the model for Hong Kong to generate 5000 synthetic data sets. In more than 99% of the draws the test rejected the unit root hypothesis at the 5% level despite the fact that it was true by construction.

Before proceeding, it is worth noting that King and Rebelo (1993) demonstrate that the HP filter can be thought of as imposing (untested) restrictions on the more general UC model. They show that the HP filter is optimal under three conditions. First, the output gap is white noise $(\phi_1 = \phi_2 = 0)$. Needless to say, this assumption squares very badly with the standard notion of the output gap as evolving gradually over time. Second, the only innovations to potential output are shocks to the rate of drift $(\sigma_y^2 = 0)$. Third, the value of the "smoothing parameter" used in computing the HP-filtering is equal to the ratio of the variance of the shocks to the output gap and the variance of the shocks to the drift of potential $(\sigma_z^2 / \sigma_\mu^2)$. It deserves to be emphasised that under these conditions the HP filter will generate estimates of potential output that are identical to those arising from the UC model (disregarding sampling uncertainty). However, if these conditions are not met, the more flexible UC model will generate better estimates of the gap.

2.2 State-Space Representation

To estimate the model we write it in state-space form.[3] To do so, let X_t denote the vector of state variables,

$$X_t^T = [y_t^p \quad z_t \quad z_{t-1} \quad \mu_t]. \tag{5}$$

As noted above, these variables are all unobserved and the purpose of the exercise below is to estimate them. Next define the vector *A* as

$$A = [1 \quad 1 \quad 0 \quad 0]. \tag{6}$$

We can then write

$$y_t = AX_t. \tag{7}$$

Equation (7) states the observed level of real GDP is a linear combination of the unobserved level of potential output and the output gap. To proceed, we need to specify the law of motion of X_t. Since higher-order AR and ARMA models can be written in AR(1) form (with the state vector suitably redefined), we assume, without loss of generality, that:

$$X_t = BX_{t-1} + \varepsilon_t \tag{8}$$

where the transition matrix, which governs the evolution over time of the state variables in the X_t-vector is given by

3 For a discussion of state-space models and the Kalman filter, see Harvey (1989) or Hamilton (1994).

$$B = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & \phi_1 & \phi_2 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \tag{9}$$

The vector of disturbances can then be written as $\varepsilon_t^T = [\varepsilon_t^y \quad \varepsilon_t^z \quad 0 \quad \varepsilon_t^\mu]$. We assume that the covariance matrix of the disturbances Ω is diagonal. This assumption implies that shocks to the output gap are unrelated to the growth rate of potential. One can think of situations in which large output gaps have persistent impacts on the long-run growth of the economy, for instance by influencing investment and the level of the capital stock. However, there appears to be no firm reason for believing that movements in the output gap have a first-order effect on the growth rate of potential and we therefore maintain the assumption that Ω is diagonal.

2.3 Estimation

To estimate the model, which is given by the *observation* equation (7) and the *transition* equation (8), we form the likelihood function:

$$\log\ L = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_1^T \log|F_t| - \frac{1}{2}\sum_1^T v_t^T F_t^{-1} v_t\ , \tag{10}$$

where T, v_t and F_t denote the sample size, the prediction errors and the mean square matrix of the prediction errors, respectively. Estimates of the model can then be obtained by numerically maximizing the likelihood function by choice of the parameters, $\Theta = \{\phi_1, \phi_2, \sigma_y^2, \sigma_z^2, \sigma_\mu^2\}$.

Since the logarithm of real economic activity is non-stationary, in estimating the model we follow the suggestions of Harvey (1989) and assume that the prior X_0 is random and has a diffuse distribution, that is, we assume that its covariance matrix is given by κI with $\kappa \to \infty$. This is tantamount to assuming that nothing is known about the initial state.

Having reviewed the model and discussed its estimation, we next turn to the results.

3. Empirical Results

As a first step, Figure 1 contains plots of the logarithm of seasonally adjusted quarterly real GDP, which we use to measure y_t, for Hong Kong (1973:1-2001:1), Korea (1973:1-2001:1), the Philippines (1981:1-2001:2), Singapore (1975:1-2001:1) and Taiwan (1973:1-2001:1).[4] For comparison purposes, we have normalized the data to equal 100 in 1990:1.

[4] The data stem from the database of CEIC Data Ltd.

The figure shows that the growth rate of the Asian economies has been declining somewhat over time. In particular, it appears that the average growth rate was lower in the 1990s than earlier. This suggests, as argued earlier, that it is appropriate to treat the growth rate of potential as time varying. Moreover, the figure shows how real economy activity fell during the Asian crisis, and, in some cases, in 1985-86. Thus, there is clear evidence of cyclical fluctuations of the type the UC model is designed to extract from the data.

Next we estimate the models. Table 1 contains the parameter estimates for the five economies. One interesting finding is that $\phi_1 > 1$ and $\phi_2 < 0$ in all cases. This implies that ε_t^z shocks will lead to "humped-shaped" responses of z_t. Thus, the output gap grows for several quarters after a positive disturbance and oscillates as it returns to the steady-state level of zero. Note also that since $\phi_1 + \phi_2$ is less than, but close to, unity, the output gap will display prolonged swings in response to disturbances, but will ultimately return to the mean level of zero.

3.1 Output Gaps

Since it is difficult to attach much intuition to the results in Table 1, we next compute the output gaps. As a preliminary it should be noted that these can be constructed in different ways depending on what information is used. One possibility is to estimate the output gap at time *t* using only data up until time *t* (that is, $z_{t|t}$). The resulting assessments can be thought of as *one-sided* or *contemporaneous estimates* since they make use of current information. Another possibility is to construct the output gap using all available data (that is, $z_{t|t}$ where $0 \leq t \leq T$). Following Stock and Watson (1991), these assessments may be thought of as *two-sided* or *retrospective estimates* of the gap in that they use future information to compute the current gap.[5] Below we present estimates of the output gap constructed in this way.

Figures 2-6 contain the extracted value of z_t for the five economies together with a ±2 standard deviations broad confidence band. While there is no reason to believe that the HP filter provides an optimal estimate of the output gap, this method is frequently used to provide an approximate measure of the gap. For comparison purposes we therefore include it in the figures.[6]

Rather than focusing on the movements of the output gaps over time, we consider some of the general features of the results. The output gaps stemming from the HP filter are typically within the confidence band of those arising from the UC model. In this sense, the two methods give similar assessments of the gap. However, note that the HP-filtered gaps are quite irregular whereas those based on the state-space model are smooth.[7] While smoothness may be an attractive feature, it should be noted that theory does not in fact offer any strong prior as to the behaviour of the gap over time. Thus, there is no formal reason why this criterion should be used to choose between alternative estimates of the gap.

5 Note that for the last observation in the sample, the two methods give identical results.

6 As is standard in the literature, in computing the HP-filtered gaps, we set the smoothing parameter, λ, equal to 1600.

7 Needless to say, one reason for this is that they are constructed using the two-sided approach.

One particularly interesting feature of the results concerns the confidence bands, which tend to be quite "broad" in the sense that they rarely suggest that the gap is significantly different from zero. One possible reaction to this is to argue that the estimates of the state-space model are too imprecise to be useful. However, the large confidence bands are better interpreted as indicating the inherent difficulty attached to estimating the output gap. It should be emphasised that estimates from other methods, such as the HP filter or regressions of the log of real GDP on a polynomial in time, are sensitive to the exact ways in which they are arrived at and thus vary between methods. Since they are typically presented without confidence bands, in interpreting them one tends to forget that the methods do not provide exact indications of the size of the gap at any point in time. By contrast, the state-space methodology renders this uncertainty explicit. Thus, we do not feel that the broad bands should be taken as evidence that the UC method is inferior to alternative modelling approaches.

Turning to the estimates for the individual economies, consider first the results for Hong Kong. Figure 2 indicates that the gap has turned sharply negative on three occasions: around 1975-76, around 1985-86 and 1998-2000. The results also suggest that in the autumn of 1998 before the Asian crisis reached Hong Kong, the economy was experiencing a cyclical boom with actual output exceeding potential by as much as three percentage points. Figure 3 indicates that economic activity in Korea exceeded potential by almost four per cent before the onset of the crisis. The subsequent contraction was extremely sharp, with output falling to six per cent below potential. The results for the Philippines, Singapore and Taiwan are provided in Figures 4-6; in the interest of brevity we do not comment on them in detail.

3.2 The Growth Rate of Potential Output

A further attractive feature of the state-space model is that it allows us to estimate the growth rate of potential GDP, μ_t, at any point in time. The growth rates of potential output for the five economies we study are presented in Figures 7-11, together with the analogous estimates computed using the HP filter.[8] Note that in both cases the growth rates are per quarter so that we need to multiply by four to obtain the corresponding annual rates. It is notable that the estimates constructed using the HP filter are quite frequently outside the $\pm 2\sigma$ broad confidence bands arising from the state-space model.

While commenting in detail on the estimates for the different economies is beyond the scope of this paper, it is interesting to note that in most cases the growth rate of potential has been declining in the 1990s. While the point estimates suggest that the quarterly growth rate of potential is typically between 1% - 1.4% (around 0.8% in the Philippines) at the end of the sample period, the confidence bands suggest that these (and any other) estimates of μ_t should be taken with a grain of salt.

3.3 Phillips Curves

In order to explore the information content of the output gaps estimated by the UC method or constructed using the HP filter, we next fit simple backward-looking Phillips curves. There exists a large and growing

8 This is computed as the first difference of HP-filtered real GDP.

literature on the appropriate specification of the inflation equation.[9] In light of the uncertainty regarding the correct specification of the inflation process, it should be stressed that the size and the significance of the parameter on the output gap are not a formal test of the appropriateness of a measure of the output gap. Despite this, simple Phillips curves have a long tradition in applied macroeconomics, and policy makers typically find them a useful tool to think about the sources of inflation pressures. A finding that one of the two measures of the output gap is empirically consistently more strongly related to inflation than the other would most likely lead many applied macroeconomists to prefer it when modelling inflation.

The Phillips curves estimated below are of the form (disregarding a constant):

$$\pi_t = \beta \pi_t^e + \delta z_{t-i} + \theta_i \pi_{t-j}^z + u_t \ , \tag{11}$$

where π_t denotes the rate of inflation (as measured by the quarterly change of the consumer price index), π_t^e the expected rate of inflation, π_t^z the rate of change of (depending on the regression) import or food prices, and u_t an iid regression residual. As a proxy for the expected rate of inflation, a lagged four-quarter moving average of actual inflation, ($\pi_t^e = (\pi_{t-1} + ... + \pi_{t-4})/4$) is used. Theory does not provide much guidance with regard to the time lag between movements in the output gap and inflation, we therefore use general-to-specific modelling strategy to determine i and j.

Since the output gap and the inflation rate were quite volatile in the 1970s and early 1980s, we estimate equation (11) on quarterly data spanning 1985:1-2001:1. The results are provided in Table 2.[10] Before reviewing the results in detail, it should be noted that the parameter on the expected rate of inflation is typically estimated to be significantly less than unity. One possible explanation for this is that the measure used is not a good proxy for the true, unobserved expected rate of inflation. If so, the resulting measurement error would tend to bias the coefficient towards zero.[11]

Consider next the results for Hong Kong. Column 2 indicates that the current output gap constructed using the UC methodology and the current change in import prices are both highly significant determinants of inflation. In column 3 we show the analogous results, using the output gap as calculated using the HP filter. These are virtually identical to those obtained in column 2. Estimating the model on data for Korea we find again that the results are insensitive to the choice of output gap measure (columns 4-5).[12] The same is true for the Philippines (columns 6-7), for which we lag the output gap by two quarters and import prices by one, and Singapore (columns 8-9). Fitting the data for Taiwan, however, is more difficult because inflation is very volatile on account of large movements in the food prices. While

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[9] This pertains to the relative importance of forward- versus backward-looking price expectations and whether the output gap or real unit labour cost is the appropriate forcing variable.

[10] The price data stem from the database of CEIC Data Ltd., except for Singapore and for the CPI in the Philippines for which we use data from the IMF's International Financial Statistics.

[11] Since this paper focuses on estimating the output gap rather than modelling the behaviour of inflation, we do not explore further the reasons for the low coefficient on expected inflation.

[12] For Korea we allow for a dummy in 1998:1 to account for the sharp increase in inflation which is due to the large depreciation of the currency in that quarter.

incorporating these in the regression instead of import prices, which are insignificant, improves the results, there is strong serial correlation in the residuals. While the autocorrelation disappears if moving-average errors of order five are allowed for, the MA-parameter is very large. Moreover, the four-quarter lagged output gap is most significant, suggesting a relatively long delay between movements in activity and inflation. The results for Taiwan should therefore be seen as tentative.

Overall, we conclude that the ability of the two measures of the output gap to explain movements in inflation is roughly similar. This finding suggests that it may be appropriate to construct output gaps with the HP filter, which is easy to use. The main attraction of the UC model is that it allows us to compute confidence bands for the output gap and thus to assess how precisely it is estimated.

4. Conclusions

In concluding, several aspects of the results discussed in this paper are worth emphasising. Most importantly, estimating the output gap or, equivalently, potential output using the UC approach appears to work well in practice. This modelling strategy has the notable benefit that it enables us to construct confidence bands, which is desirable because they show how much (or how little) in fact is known about the precise size of the gap. The results also show that, in practice, output gaps constructed using the HP filter contain much the same information for inflation as the gaps computed using the UC approach, at least for the five economies studied here. Since the HP filter is trivial to use, it seems likely that it will be the preferred measure in applied research.

Finally it should be noted that the output gaps discussed above were all obtained using data on a single time series for each economy. Of course, expanding the information set employed to estimate the gap to include inflation and other variables that are correlated with the output gap, such as private sector saving, is a worthwhile project for future research.

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Table 1: Maximum Likelihood Estimates

	Hong Kong 1973:1 - 2001:1	Singapore 1975:1 - 2001:1	Korea 1973:1 - 2001:1	Taiwan 1973:1 - 2001:1	Philippines 1981:1 - 2001:2
ϕ_1	1.401 (0.206) [6.813]	1.701 (0.150) [11.350]	1.801 (0.158) [11.370]	1.664 (0.152) [10.969]	1.589 (0.091) [17.397]
ϕ_2	-0.531 (0.108) [-4.911]	-0.790 (0.132) [-6.001]	-0.979 (0.020) [-49.198]	-0.701 (0.142) [-4.927]	-0.631 (0.090) [-7.024]
σ_y^2	0.607	0.309	0.416	0.191	0.463
σ_μ^2 x 100	0.091	0.749	0.145	0.387	0.357
σ_z^2	0.301	0.042	0.095	0.071	0.121
Log-likelihood	407.76	418.57	418.88	479.39	315.86

Notes : Standard errors in parentheses and t-statistics in brackets.

Table 2: OLS Estimates of Phillips Curves

Sample period: 1985:1-2001:1

	Hong Kong		Korea		Philippines		Singapore		Taiwan	
Constant	0.00 (0.62)	0.00 (0.13)	0.00* (2.08)	0.01* (2.24)	0.02** (5.69)	0.01** (5.67)	0.00** (2.83)	0.00** (3.00)	-0.00 (0.23)	0.00 (0.68)
Expected inflation	0.89** (12.19)	0.93** (12.90)	0.56** (3.25)	0.55** (3.29)	0.20* (2.22)	0.24** (2.76)	0.54** (3.41)	0.51** (3.23)	0.47** (6.74)	0.44** (6.47)
UC gap	0.12** (3.29)		0.11* (2.46)		0.28* (3.73)		0.08* (2.32)		0.10** (2.67)	
HP gap		0.08** (2.89)		0.11** (3.00)		0.25** (4.43)		0.05* (2.54)		0.10** (3.04)
Import prices	0.16* (2.22)	0.17* (2.32)			0.06* (2.51)	0.05* (2.34)	0.06* (3.01)	0.06 (3.01)		
Food prices									0.36** (30.70)	0.36** (31.25)
Lagged food prices									0.05** (4.04)	0.05** (3.78)
MA(5)									-0.92** (31.29)	-0.92** (31.37)
Dummy (98:1)			0.04** (5.40)	0.05** (5.67)						
Lag for gap	*t*	*t*	*t*	*t*	*t*-2	*t*-2	*t*	*t*	*t*-4	*t*-4
Lag for import prices	*t*	*t*	*t*	*t*	*t*-1	*t*-1	*t*	*t*	*t*	*t*
DW	2.32	2.35	1.81	1.81	1.99	2.08	1.77	1.74	2.16	2.12
Adj. R-sq.	0.76	0.76	0.36	0.39	0.32	0.36	0.41	0.42	0.91	0.91

Notes: *t*-statistics in parentheses, ( ). */** denotes significance at 5%/1% level.

Figure 1: Real GDP

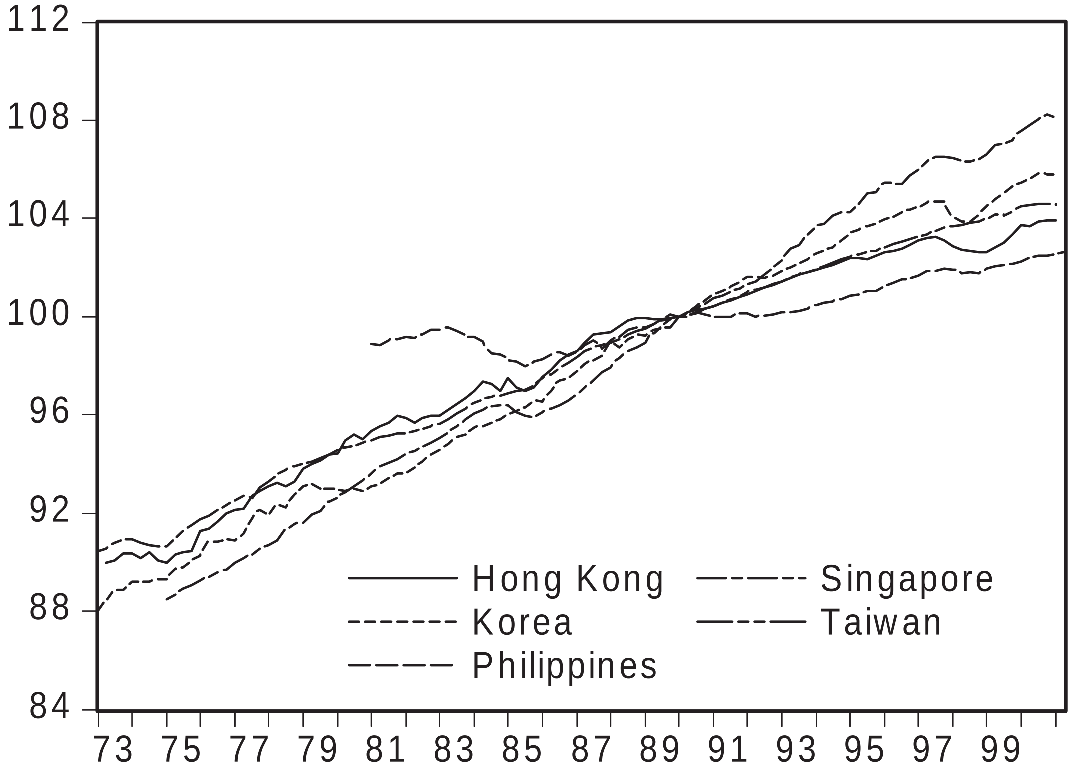

Figure 2: Hong Kong – Output Gap

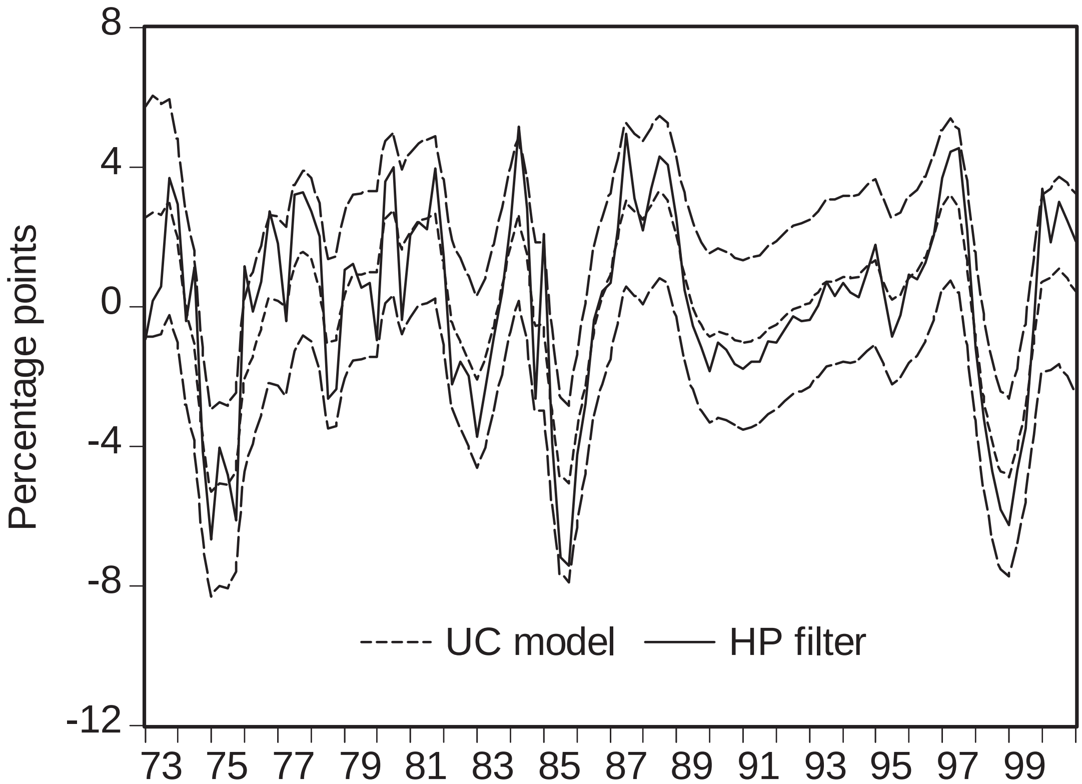

Figure 3: Korea – Output Gap

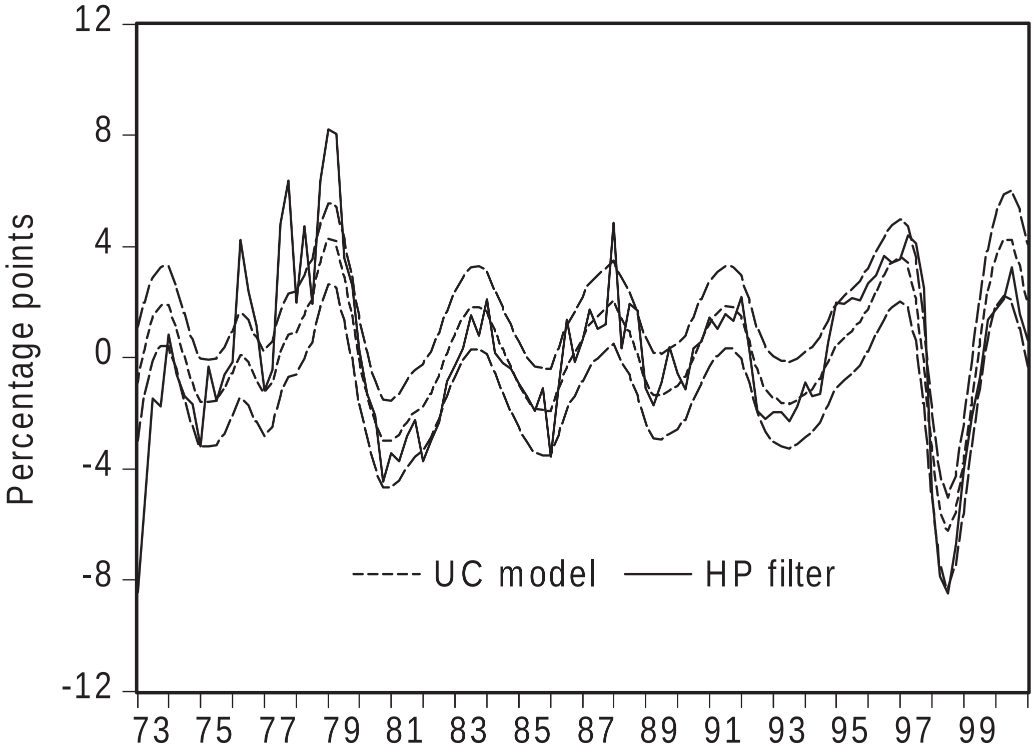

Figure 4: Philippines – Output Gap

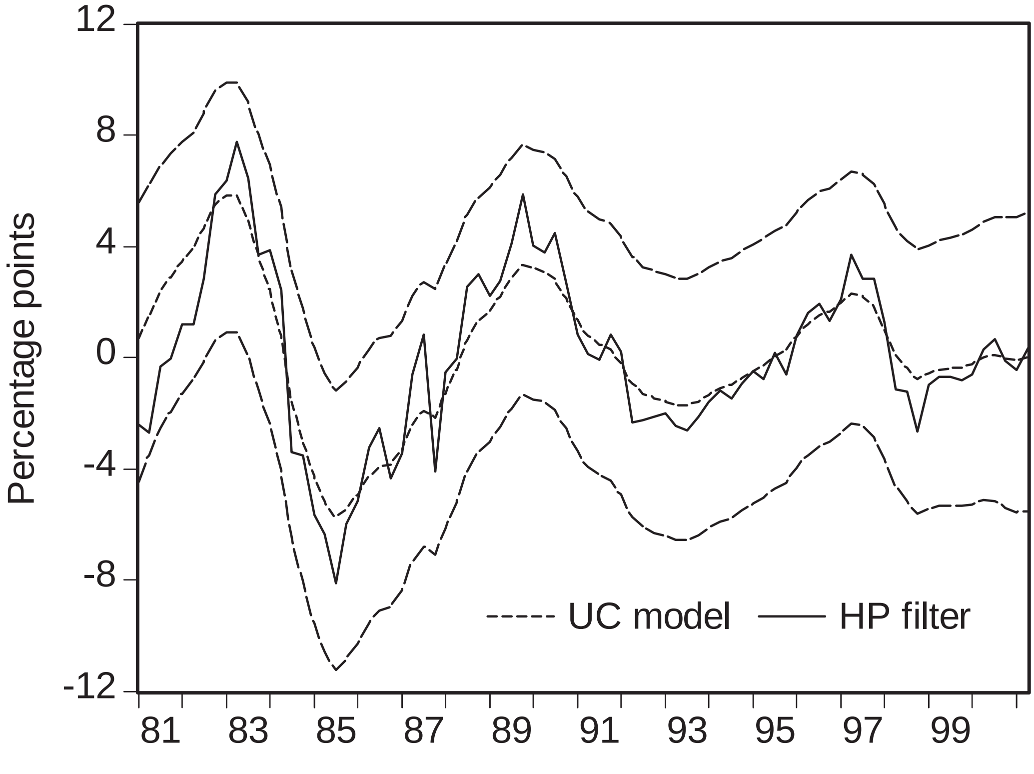

Figure 5: Singapore – Output Gap

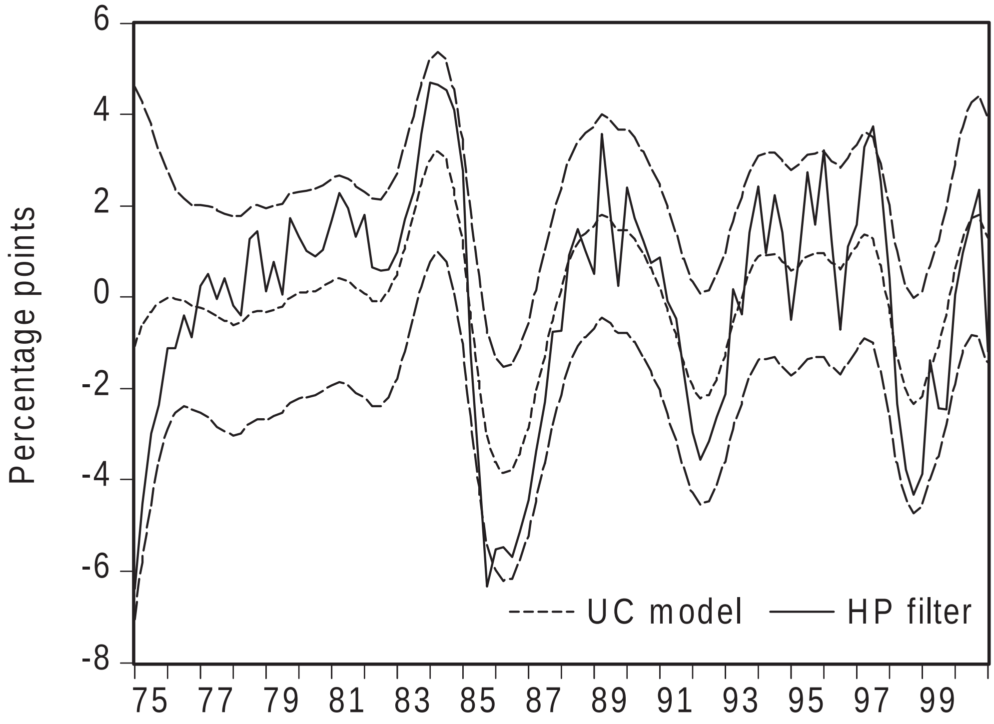

Figure 6: Taiwan – Output Gap

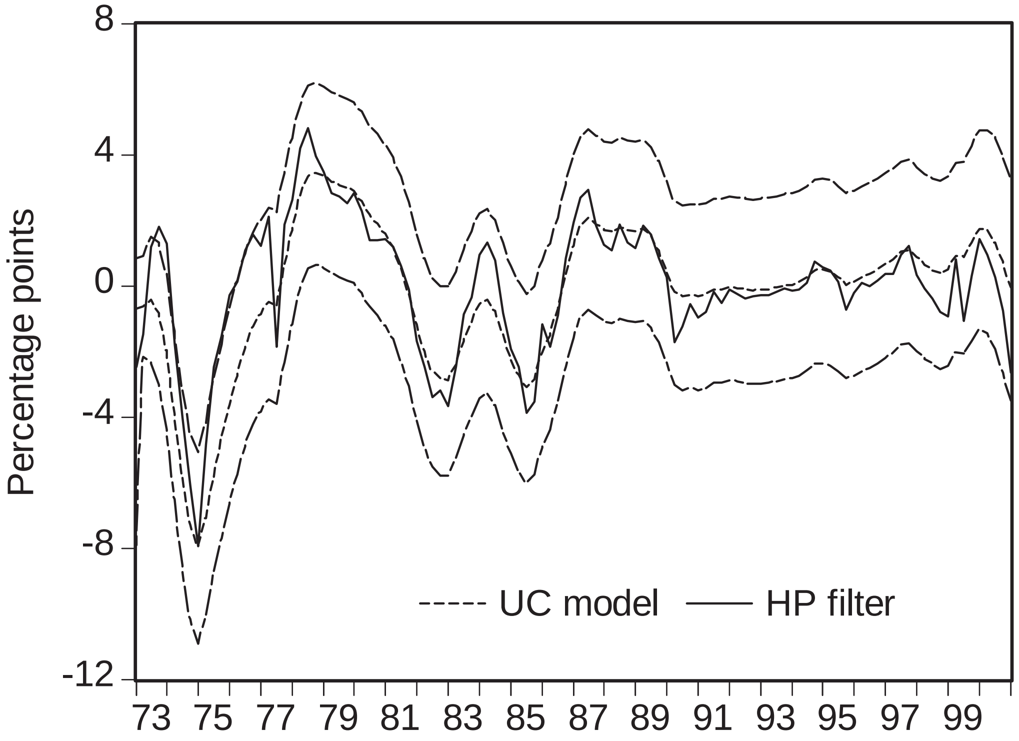

Figure 7: Hong Kong – Growth of Potential

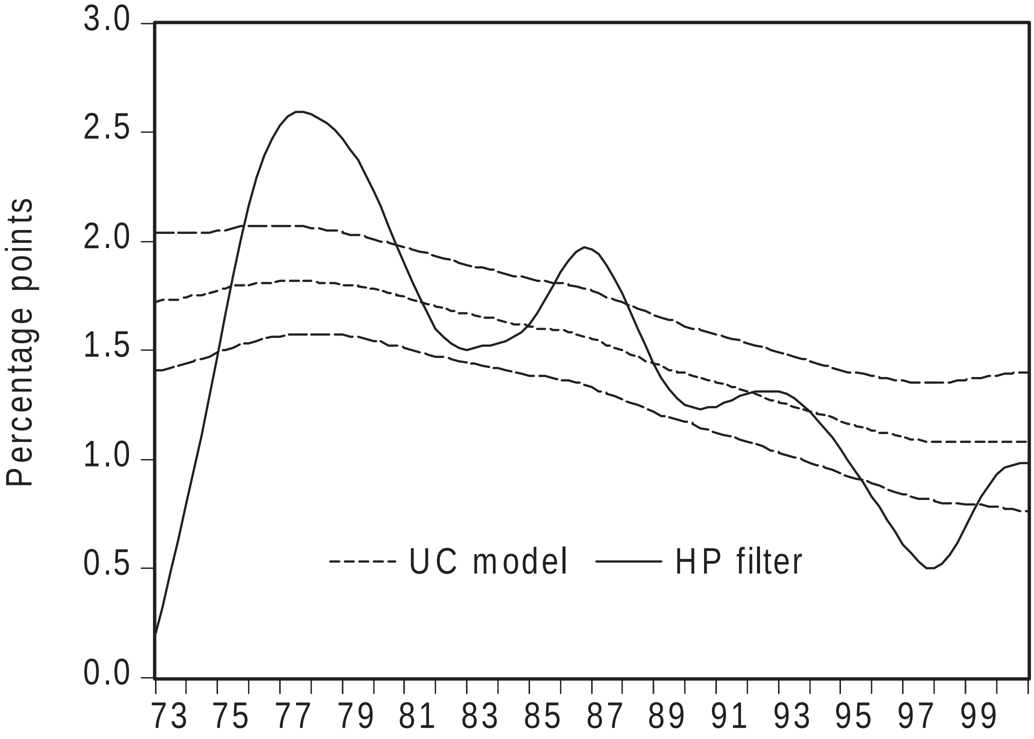

Figure 8: Korea – Growth of Potential

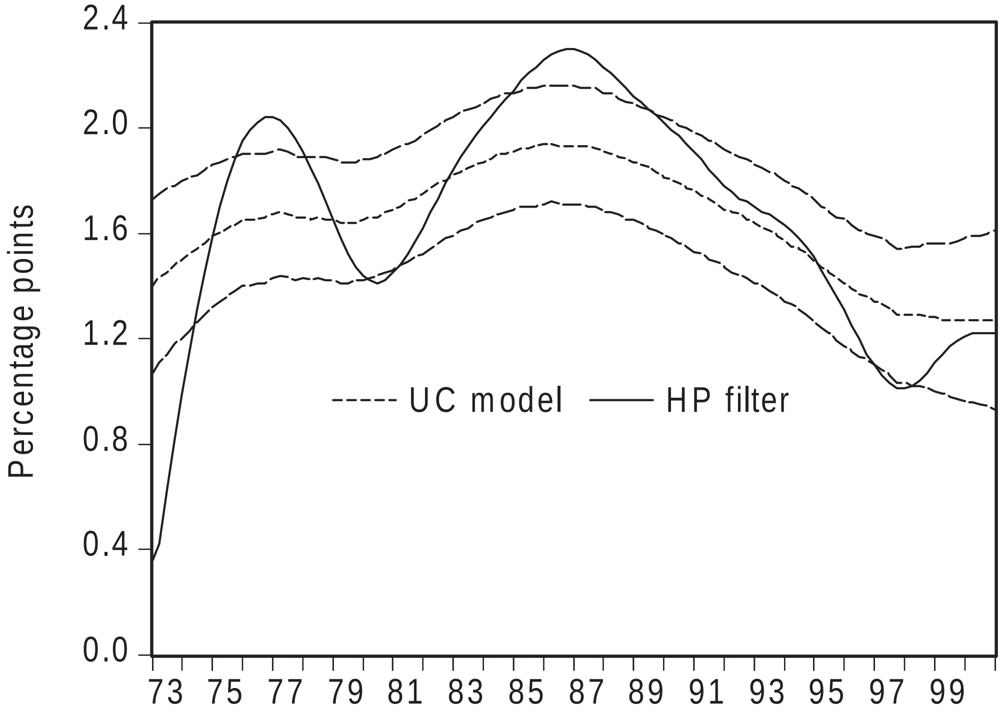

Figure 9: Philippines – Growth of Potential

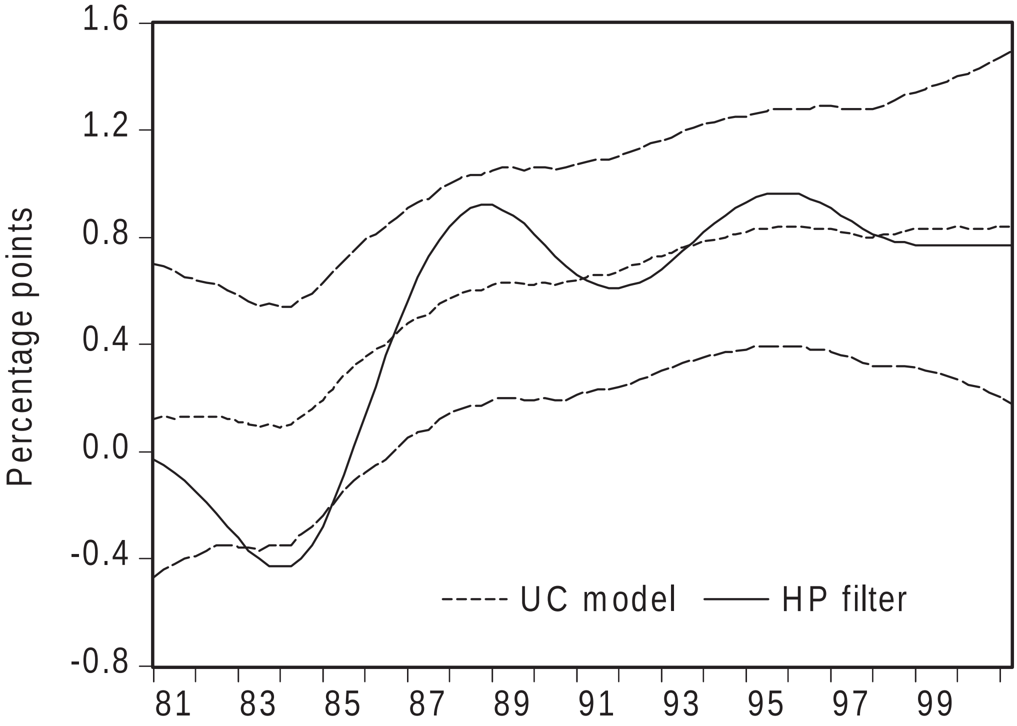

Figure 10: Singapore – Growth of Potential

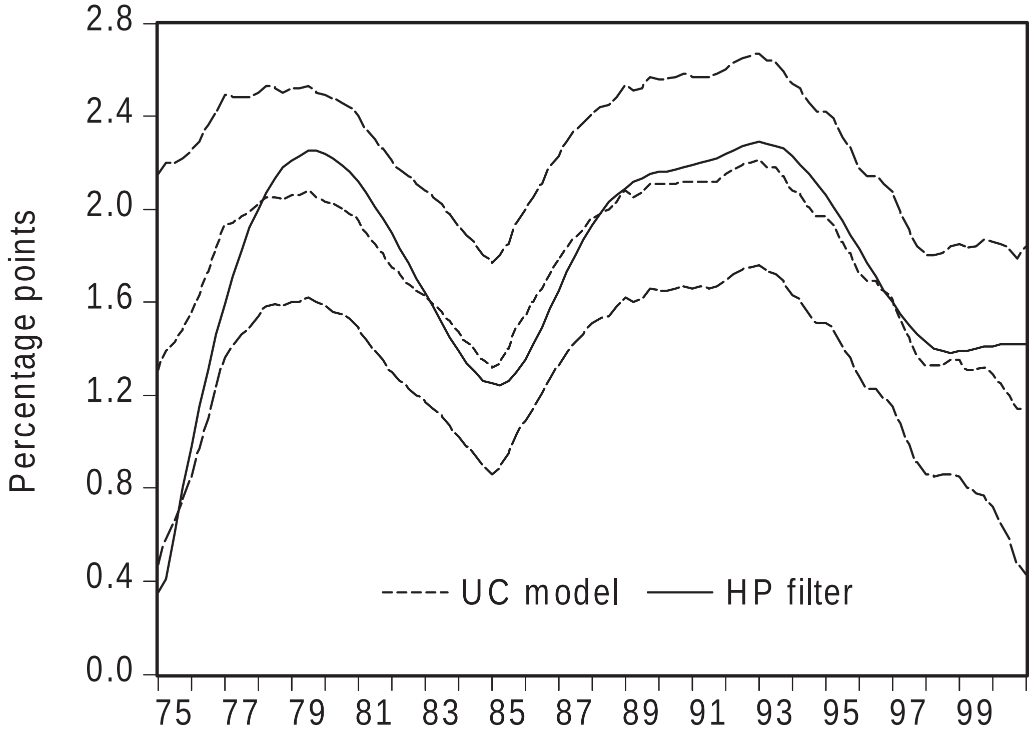

Figure 11: Taiwan – Growth of Potential